A Comparative Study Of Epidermal Characters Of Two Species Of Genus Adhatoda

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Abstract: Two species of genus Adhatoda (A. beddomei L. and A. vasica L.) was selected for epidermal studies of leaves. 14 epidermal characteristics are studied in two species of Adhatoda (A. beddomei L. and A. vasica L.). These characters belong broadly to prominent structures. 1. Epidermis 2. Stomata 3. Trichomes. Adhatoda vasica L. differs distinctly from Adhatoda beddomei L. in numbers of epidermal cells. Out of 8 stomatal characteristics studied, 2 character namely average size of stomata and stomatal index show least variation in both species. Type of stomata is quite similar in both i.e. diacytic. However, some variations occur in average number of stomata/unit area in both species of Adhatoda respectively. Similarly they differ invariably in distance between stomata, guard cell index, pore area index and total pore area characteristic.

Index Terms- Adhatoda, Stomata, Epidermis, Diacytic, Stomatal index.

I. Introduction

Acanthaceae is divided in two subfamilies depending upon the presence or absence of jaculators, i.e. the curved retinacula which support the seeds. Adhatoda is the most important member of Acanthaceae family. Two species of genus Adhatoda (A. beddomei L. and A. vasica L.) was selected for epidermal studies of leaves. Adhatoda beddomei L. is endemic to India occurring in the Travancore hills of south western Ghat, Valparai (South Arcot), Akkamalai (Coimbatore) and Mahendragiri (Kanniyakumari dist.), Southern parts of India, Kerala. Adhatoda vasica L. is native to Asia. The plant is found abundantly in wild in all over India. The plant is found in throughout India, the sub-Himalayan tracts eastwards, Dehra Dun, Gujarat, Rajasthan (Awan et al.,2014).
1.1 Botanical description of *A. beddomei* L.

**Habit** – Perennial shrub

**Stem** – Stem is herbaceous, aerial, cylindrical. Stem are light green in colour. Average plant height is 147 cm. Average plant spread is 208 cm. The average length of smallest branch is 22.81 cm. Average number of node/branch is 25.21.

**Leaf** – Simple light green leaves are ovate, leaf margin serrate, phyllotaxy of leaf is opposite. Leaf are cauline and ramal and extipulate. Leaves are glabrous. Leaves are petiolate. The average size of leaf is 9.68×5.26 cm and the average size of petiole 0.0136 cm.

**Inflorescence** – Racemose spike.

**Flower** – Flowers in short dense axillary pedunculate spike, towards the end of the branches, bracteate, bracteolate, bract and bracteoles are leafy. Flowers are sessils, complete, zygomorphic, bracts are three elliptic, subacute, glabrous, 5-7 nerved, closely reticulate veined. Bracteoles are oblong–lanceolate, acute with ciliolate margins. Bracteoles are one nerved, reticulate veined. The average size of bract is 1.204 × 0.35 cm and light green in colour.

**Calyx** – Sepals are five, polysepalous, slightly connate at the base. Sepal aestivation is quincuncial and green in colour. Sepals are glabrous or slightly pubescent. Segments are oblong lanceolate, acute, three–nerved, and reticulately veined. The average size of sepal is 0.38 × 0.21 cm.

**Corolla** – Petals are five gamopetalous. Petal aestivation is valvate. Corolla is a white with a few irregular rose–coloured bars in the throat which is called coronary outgrowth. Corolla is 2/3 bilabiate in which the upper half laterally inflated long. Ovate–oblong, curved, obtuse, notched. The lower lip as long as the upper, the lobes 1/2 inch deep, oblong, rounded. Lower lip has a groove in the centre in which style lies in bud condition. The middle lobe has the maximum width. The average size of petal is 1.084 × 0.428 cm. The average size of corolla tube also present in this species. However, it is shorter than those found in flowers of *A. vasica*.

**Androecium** – Stamens are two in a number. Stamens are polyandrous, epipetalous, dithecous, the anther lobes are situated at unequal heights and the lower one bears an appendage basifixed, introse. The average size of anther is 0.14×0.07 cm and white with deep red colour. Average size of anther filament is 0.82 cm.
Gynoecium- Ovary is a pubescent, bicarpellary, syncarpous, ovary superior. Ovary is a bilocular with two ovules in each locules. The placentation is axile. Style is long and curved. White style and light green stigma are present. The average size of style is 0.88 cm. Stigma is capitate.

Fruit- Fruit is capsule. Capsule is clavate, subacute, shortly and bluntly pointed. Capsule has a pubescent and solid stalk. The average size is 2.75×1.18 cm. They are hard in a texture. Fruits are light green at a young stage and after maturity it is brown in colour.

Seed – Three seeds are present in a fruit. Seeds are orbicular – oblong. The average size of seed is 0.62 × 0.58 cm. Seed are rough in a texture and brown in colour.

1.2 Botanical Discription of *Adhatoda vasica* L.

It is a perennial shrub. Stem is herbaceous, aerial, cylindrical with many long opposite ascending branches and solid. Lower portions of stem are woody, nodes swollen and flat, rough and pale yellow. The average plant height is almost 145 cm. Average plant spread is calculated as 475 cm. The average length of smallest branch is 27.61. Average number of node/ branch is 18.22. Some leaf characters are similar to previous species.

Leaves are elliptic lanceolate opposite decussate and dark green in colour. The average size of leaf is 16.73 × 6.46 cm. The average size of petiole is 1.12 cm.

*A. vasica* differs distinctly from *A. beddomei* in many floral and fruit characteristics. Overall floral parts in this species are quite larger than those found in *A. beddomei*. The anthers are light green in this species as compare to white and deep red anther of *A. beddomei*. Qualitatively both species resemble much with reference to flower and fruit characters. The present research work focused on epidermal variability in both plants.

II. MATERIAL AND METHODOLOGY

2.1 Plant Material

*A. beddomei* and *A. vasica* are the wild plant species, which are commonly grown in waste land and gardens of Jaipur city. Fresh leaves were collected from certain garden and Arboretum of the Jaipur city.

2.2 Methodology

2.2.1 Epidermal Studies

Leaves of both species of genus *Adhatoda* are collected for epidermal studies. Samples of materials for slide preparation are taken from same region of each fresh leaf, generally from midway between the leaf base and apex of lamina including the midrib. The epidermal peels are obtained using a sharp pointed forcep. A thin layer of nail polish was also spread over the leaf surface. The strips are thoroughly washed with distilled water, stained with saffaranin and then mounted with a drop pure glycerin jelly on a glass slide. A cover slip was placed over the drop and sealed with nail polish. The size of epidermal cell and stomata size of pore, distance between stomata determined using ocular micrometer and stage. The data of above said aspects were carried out at X450 magnification in the compound microscope. The measurable data are presented as arithmetic mean (\(\bar{x}\)) standard error (S.E.)
2.2.2 Stomata Index: The stomatal index was calculated by the following formula.

\[ I = \frac{S}{E+S} \times 100 \]

Where,

\[ I \] = Stomatal index, \[ S \] = Number of stomata per unit area, \[ E \] = Number of epidermal cell per unit area

2.2.3 Guard Cell Index (GCI): GCI calculated by following formula

\[ GCI = \frac{\text{No. of guard cell/unit area}}{\text{No. of guard cell + subsidiary cell + no. of epidermal cell/unit area}} \times 100 \]

2.2.4 Pore Area Index (PAI): PAI calculated by following formula

\[ PAI = \frac{\text{Mean pore area} \times \text{Mean b of stomata}}{\text{mean no. of stomata/ unit area}} \times 100 \]

2.2.5 Total Pore Area (TPA): TPA calculated by following formula

\[ TPA = \frac{\text{Mean pore area} \times \text{mean no. of stomata / unit area}}{10^6} \times 100 \]

III. RESULT AND DISCUSSION

a) Stomata

b) Multicelled trichome
Many parameters related to epidermal studies of *Adhatoda* species are described. Epidermal characters are studied as number of epidermal cells (per unit area), size of epidermal cell, type of epidermal cell, number of stomata, size of stomata, type of stomata, stomatal index, distance between stomata, number of guard cell (per unit area), size of pore (L × B), number of subsidiary cell, size of trichomes, type of cystoliths. The details of above said characteristics are given in Table 1 and Figs. 3(a)-3(f).

These epidermal characters have been described plant wise.

### Table 1 : Comparative data of epidermal characters of *Adhatoda* spp.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant species Character</th>
<th><em>Adhatoda beddomei</em> L.</th>
<th><em>Adhatoda vasica</em> L.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upper</td>
<td>Lower</td>
</tr>
<tr>
<td>1.</td>
<td>Average number of epidermal cell</td>
<td>Absent</td>
<td>104±17.862</td>
</tr>
<tr>
<td>2.</td>
<td>Av. size of epidermal cell (µm)</td>
<td>Absent</td>
<td>34.30×26.6±6.640×2.480</td>
</tr>
<tr>
<td>3.</td>
<td>Type of epidermal cell</td>
<td>Absent</td>
<td>Sinuous</td>
</tr>
<tr>
<td>4.</td>
<td>Av. number of stomata</td>
<td>Absent</td>
<td>27±0.531</td>
</tr>
</tbody>
</table>

Figure 3:(a) Lower epidermis of *A. beddomei* (X200) (b) Multicelled long trichome of *A. beddomei* (X400) (c) Upper epidermis of *A. vasica* (X200) (d) Part of lower epidermis of *A. vasica* (X200) (e) Trichomes of *A. vasica* (X400) (f) Lower epidermis showing elongated cystolith (X400)
<table>
<thead>
<tr>
<th></th>
<th>Av. size of stomata (µm)</th>
<th>Type of stomata</th>
<th>Stomatal index</th>
<th>Distance between stomata (µm)</th>
<th>Guard cell index (GCI) (µm)</th>
<th>Pore area index (PAI)</th>
<th>Total pore area (TPA)</th>
<th>Av. number of trichome</th>
<th>Av. size of trichome (µm)</th>
<th>Av. size of cystolith (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Absent</td>
<td></td>
<td></td>
<td>32.91±21.00 ± 3.130±2.097</td>
<td>28.43±20.31 ± 1.013±0.396</td>
<td></td>
<td>0.358±0.009</td>
<td>12.01±0.395</td>
<td>45.65±19.76 ±15.737×1.653</td>
<td>53.76±20.10 ±17.019 ×1.009</td>
</tr>
<tr>
<td>6.</td>
<td>Diacytic</td>
<td></td>
<td></td>
<td>20.61±1.671</td>
<td>59.54±4.313</td>
<td>20.56±6.43</td>
<td>0.289±0.013</td>
<td>8.32±1.913</td>
<td>102×12.41 ±24.981×1.318</td>
<td>122×16.10 ±22.10×2.10</td>
</tr>
<tr>
<td>8.</td>
<td>Diacytic</td>
<td></td>
<td></td>
<td>29.657±3.01</td>
<td>34.625±4.31</td>
<td>13.397±1.13</td>
<td>0.187±0.002</td>
<td>17.41±0.868</td>
<td>55.41±21.55 ±9.322×1.093</td>
<td>55.41±21.55 ±9.322×1.093</td>
</tr>
<tr>
<td>9.</td>
<td>Diacytic</td>
<td></td>
<td></td>
<td>26.09±8.932</td>
<td>34.625±4.31</td>
<td></td>
<td>0.358±0.009</td>
<td>12.01±0.395</td>
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<td></td>
<td></td>
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<td>34.625±4.31</td>
<td></td>
<td>13.397±1.13</td>
<td>17.41±0.868</td>
<td>119×15.40 ±24.86×1.578</td>
<td>119×15.40 ±15.40×2.10</td>
</tr>
</tbody>
</table>

### 3.1 Adhatoda beddomei L.

The average number of epidermal cells / unit area are observed 104±17.862 Fig.3(a). The average size of epidermal cells are 34.301±26.610 µm ± 6.640 × 2.480 (Table 1). The average number of stomata are 27±0.531. The average size of stomata is 32.91±21.00µm ± 3.130×2.097. Stomatal index is calculated as 20.61±1.671 (Table 1). Distance between stomata and guard cell index are 46.090 µm ± 8.932 and 24.602 cm ± 5.463. Pore area index (PAI) and total pore are (TPA) are 20.561±6.432 and 0.358 ± 0.009 respectively. The average number of trichome / unit area is 12.01±0.395. The average size of trichome is 102×12.41 µm ±24.981 × 1.318. In this species solitary semi round cystolith are present. Their average size is 48.35×21.32 µm ± 16.507×1.769 for lower epidermis. Similarly on upper epidermis the average size of cystolith is quite similar (Table1).

### 3.2 Adhatoda vasica L.

The average number of epidermal cell / unit area is lesser in comparison to those in Adhatoda beddomei L. Fig.3(c). However, in this species amphiblastic type of stomata occur. The number of upper epidermal cells and lower epidermis cells are calculated as 95.3±6.031 and 92.5±10.625. The average size of upper and lower epidermis are calculated as 28.31µ×36.63 µm ± 1.019 × 3.231 and 30.1×42.7µm ± 3.278×5.761. Straight type of epidermal cells are observed in A. vasica L. Fig.3 (d). The average number of stomata / unit area of upper epidermis and lower epidermis is 32±1.639 and 39±0.735 respectively (Table 1).

Average size of stomata of upper epidermis and lower epidermis is 28.43×20.31 µm ± 1.013 × 0.396 and 30.52×20.01 µm ± 12.012×2.228. The stomatal index of upper and lower epidermis is quite similar (Table 1).
Distance between stomata of upper and lower epidermis is 59.554 µm ± 4.313 and 54.610 µm ± 6.031. Guard cell index of upper and lower epidermis has not much variation (Table:1). Pore area index of upper and lower epidermis is 10.932±2.679 and 13.397±1.131 respectively.

Total pore area of upper and lower epidermis is 0.289 ± 0.013 and 0.187±0.002. Average number of trichome per unit area on both surface have variation i.e. on upper epidermis 8.32±1.913 and on lower epidermis 17.41±0.868. Average size of trichomes of upper and lower epidermis is 122×16.10 µm ± 22.101 × 2.101 and 119×15.40 µm ± 24.861 × 1.578

IV. DISCUSSION

Some variation were observed in many epidermal characters in both species of Adhatoda, i.e., average number of epidermal cell per unit area, type of epidermal cell, stomatal index, distance between stomata, size of trichome type of trichome and type of cystolith. Verma and Murty (1979), Grewal (2000) and Cutler et al. (2007) have reported the Diacytic type of stomata in Adhatoda species. We have also observed diacytic (caryophyllaceous) type of stomata which are surrounding by two subsidiary cells, the common wall of which is at right angle to the longitudinal axis of the stomata. We have found more distance between stomata in comparison to less distance between stomata as reported by (Prakash and Kumar, 1995). Adhatoda vasica L. are amphiblastic in nature where is the general epidermal characters on upper and lower sides of the leaf in A. vasica are concerned, there are usually have not much variation in these characters except that stomata less in number of upper surface as compared to lower surface. Akhtar and Syed (2006) reported amphiblastic stomata of Adhatoda species. In both above said plant species the leaf is amphiblastic. Trichomes are long with tapering end and uni, multicelled. They occur singly are condensed in Adhatoda vasica. In Adhatoda vasica L. the average number of trichomes/unit area is the highest among all four species studied by me. However, these species differ from each other whereas the average size of trichome is concerned. Akhtar and Syed (2006) have reported the different type of trichome in above said species. We have found non glandular trichome in Adhatoda species. Inamdar (1970), Kumar and Paliwal (1978) and Shendage and Yadav (2009) have studied trichome in Adhatoda spp. We have also observed unicellular, shaggy, glandular shaped trichome in Adhatoda species. This view of also supported by Srivastava and Choudhary (2006), Somprasong et al., 2014. A prominent structures occur in all four species in cystolith observed by me. Cystolith consist of cellulose and are impregnated with calcium carbonate and they are irregular in shape. In both Adhatoda spp. elongated cystoliths with blunt extremities are observed. Previously, Shendge and Yadav (2009) have reported solitary elongated and round cystoliths in Adhatoda spp. The presence of cystoliths is also confirmed by Labhane (2011), Patil and Patil (2012).Gabel et al. 2021 documented distribution of cystoliths in the leaves of Acanthaceae and its effect on leaf surface anatomy in 28 species. Khan et al., 2020 study the phylogeny of the various selected genera of Acanthaceae was investigated based on macromorphological characters, chloroplast DNA (cp-DNA) genes rbcL, matK and intergenic spacer trnH-psbA sequences.

V. CONCLUSION

Present work gives a brief detail about the epidermal characters of both plant species of Adhatoda genus. The given data suggested that both plant species have many similar characters. However, the have many distinguished characters. The epidermal characters are very important because it gives an elementary idea about functional position of a leaf. As well as it may also help in plant physiology, respiration mechanism and
pollution condition of a particular area. The work underscores the significance of stomatal features in delineating various taxonomic levels within plant groups. The variability in stomatal frequency can be particularly informative at the genus level, aiding in the differentiation of different genera. The presented work may be a stack holder for further studies.

VI. REFERENCES


